# COSEWIC
# Assessment and Status Report

on the

# Eastern Ribbonsnake
## *Thamnophis sauritus*

Atlantic population
Great Lakes population

**in Canada**

**Atlantic population - THREATENED**
**Great Lakes population - SPECIAL CONCERN**
**2012**

**COSEWIC**
Committee on the Status
of Endangered Wildlife
in Canada

**COSEPAC**
Comité sur la situation
des espèces en péril
au Canada

COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:

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# COSEWIC
# Assessment Summary

**Assessment Summary – November 2012**

**Common name**
Eastern Ribbonsnake - Atlantic population

**Scientific name**
*Thamnophis sauritus*

**Status**
Threatened

**Reason for designation**
Recent extensive survey efforts to quantify the abundance and distribution of this cryptic and hard to identify snake confirm that it is rare and has a very small distribution. However, little is known about population trends. Fluctuations in population numbers and a continuing decline in overall numbers of mature individuals are suspected; both increase the susceptibility to stochastic events. Shoreline development and its associated risk is an increasing threat throughout much of the range.

**Occurrence**
Nova Scotia

**Status history**
Designated Threatened in May 2002. Status re-examined and confirmed in November 2012.

**Assessment Summary – November 2012**

**Common name**
Eastern Ribbonsnake - Great Lakes population

**Scientific name**
*Thamnophis sauritus*

**Status**
Special Concern

**Reason for designation**
The Great Lakes population is relatively widespread and appears to be locally abundant in a few sites. However, quantitative data are lacking on population size and trends, and most information is anecdotal and from protected areas. Wetland and shoreline habitat loss and road development continue at an alarming rate within their range and present a significant threat to the species. Unless those losses are reversed the species is at risk of becoming Threatened. Road mortality and habitat loss are widespread and much of the species distribution occurs in pockets of habitat surrounded by agricultural land, roads and shoreline development.

**Occurrence**
Ontario, Quebec

**Status history**
Designated Special Concern in May 2002. Status re-examined and confirmed in November 2012.

# COSEWIC
# Executive Summary

## Eastern Ribbonsnake
*Thamnophis sauritus*

Atlantic population
Great Lakes population

### Wildlife Species Description and Significance

The Eastern Ribbonsnake is a small, slender semi-aquatic snake with a long tail. It can be identified by its black body with three, longitudinal yellow stripes, two lateral and one dorsal, running the length of the body. The side stripes occur on the 3rd and 4th scale rows. Below the stripe, the scales are caramel to rusty brown. There is a vertical white line in front of the eye.

### Distribution

Eastern Ribbonsnakes range from southern Canada to Florida, east of the Mississippi River. There are four recognized sub-species of the Eastern Ribbonsnake; of these only the Northern Ribbonsnake (*T. s. septentrionalis*) occurs in Canada. Eastern Ribbonsnakes occur at the northern limit of their range in Canada, where there are two geographically distinct populations that are each considered a designatable unit. The Great Lakes population occurs in southern Ontario and extreme southern Quebec and is contiguous with the species' main USA range. The Atlantic population is isolated and restricted to southwest Nova Scotia.

### Habitat

Eastern Ribbonsnakes are found in a variety of wetland habitats with both flowing and standing water such as marshes, bogs, fens, ponds, lake shorelines and wet meadows. Most sightings of Eastern Ribbonsnakes outside of the overwintering period occur near the water's edge. Eastern Ribbonsnakes spend winter in underground hibernacula where they must avoid freezing and dessication. They may hibernate in well-drained sites or in areas close to water and may even be completely submerged inside their hibernacula. Some Eastern Ribbonsnakes may move considerable distances from water to overwinter in forested areas, but the extent of movements to their hibernation sites is not known.

## Biology

Eastern Ribbonsnakes feed mostly on amphibians and small fish. They appear to feed throughout their active season, although feeding modes and prey may vary seasonally with amphibian activity. Courtship and mating generally occur in spring, although fall mating may also occur. Eastern Ribbonsnakes give live birth to 2-26 young in July or August. Eastern Ribbonsnakes can reach maturity in their second or third year. Generation time is likely no more than 4-6 years.

Eastern Ribbonsnakes in Canada are constrained by temperature. They bask in exposed sunny spots to gain sufficient heat for movement, gestation and digestion. They take refuge in water, under vegetation, beneath cover objects and in shrubs to avoid overheating and to escape from predators.

## Population Sizes and Trends

There are few quantitative data on population sizes and trends in Canada. Throughout their range, Eastern Ribbonsnakes appear to be patchily distributed but locally abundant. In the Great Lakes population, they are believed to occur in relatively high densities in many of the wetlands where they are found. In the Atlantic population, distributional surveys suggest that abundance may vary considerably and that it may not regularly reach the high densities reported elsewhere. There is limited evidence that some Eastern Ribbonsnake populations may be declining in parts of Nova Scotia.

## Threats and Limiting Factors

Loss of wetland habitat and development of lakeshores are increasing, particularly in Ontario. These changes can lead to habitat fragmentation, degradation and loss. Increased road development and traffic frequency, greater likelihood of negative interactions with people, increased predation by pets, and increased introduction of exotic species are also threats associated with anthropogenic development of shorelines. Critical information on population size and trends is still lacking which could prevent recognition of overall population decline and impacts of threats.

## Protection, Status, and Ranks

The Atlantic population was designated Threatened by COSEWIC in 2002 because it is a small, isolated population susceptible to demographic and environmental fluctuations and threatened by shoreline development. It is currently listed on Schedule 1 of the federal *Species at Risk Act* (SARA) and a federal recovery strategy is in place. The Atlantic population is also listed as Threatened under the Nova Scotia *Endangered Species Act*.

The 2002 COSEWIC status assessment identified the Great Lakes population of Eastern Ribbonsnakes as Special Concern because of a lack of quantitative data on population size and trends, extensive loss and modification of wetland and shoreline habitats, and the snake's susceptibility to road mortality. This population is currently listed on Schedule 1 of SARA as Special Concern. Eastern Ribbonsnakes in Ontario are also identified as Special Concern under the Ontario *Endangered Species Act, 2007* (ESA). Eastern Ribbonsnakes are listed as S2 under Quebec's provincial legislation, *An Act Respecting Threatened or Vulnerable Species*.

## TECHNICAL SUMMARY - Atlantic population

*Thamnophis sauritus*
Eastern Ribbonsnake
Atlantic population
Range of occurrence in Canada: Nova Scotia

Couleuvre mince
Population de l'Atlantique

**Demographic Information**

| | |
|---|---|
| Generation time | ~ 4-6 yrs |
| Is there an [observed, inferred, or projected] continuing decline in number of mature individuals? | Inferred decline (based on habitat loss, local surveys, and anecdotal records) |
| Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations] | Unknown |
| [Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations]. | Unknown |
| [Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations]. | Unknown |
| [Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future. | Unknown |
| Are the causes of the decline clearly reversible and understood and ceased? | No |
| Are there extreme fluctuations in number of mature individuals? There is some evidence of local fluctuations, but the species' biology does not indicate this and the bevidence may reflect variation in catchability rather than true fluctuation in population size. | Unknown, but not likely |

**Extent and Occupancy Information**

| | |
|---|---|
| Estimated extent of occurrence | 2931 km² |
| Index of area of occupancy (IAO)<br>(Always report 2x2 grid value). | 332 km² |
| Is the total population severely fragmented? | No |
| Number of locations*<br><br>(based on the threats of shoreline development, water level alteration and exotic invasive species – see **Canadian Range** Atlantic Population) | 26 |
| Is there an [observed, inferred, or projected] continuing decline in extent of occurrence? | Unknown |
| Is there an [observed, inferred, or projected] continuing decline in index of area of occupancy? | Unknown |
| Is there an [observed, inferred, or projected] continuing decline in number of populations? | Unknown |
| Is there an [observed, inferred, or projected] continuing decline in number of locations*? | Unknown |
| Is there an [observed, inferred, or projected] continuing decline in [area, extent and/or quality] of habitat? | Yes – projected decline in area and quality of habitat |
| Are there extreme fluctuations in number of populations? | Unknown, unlikely |
| Are there extreme fluctuations in number of locations*? | Unknown, unlikely |

| | |
|---|---|
| Are there extreme fluctuations in extent of occurrence? | No |
| Are there extreme fluctuations in index of area of occupancy? | Unknown, unlikely |

**Number of Mature Individuals (in each population)**

| Population | N Mature Individuals |
|---|---|
| Atlantic Population | Unknown (rough, highly uncertain estimate 4000-9000) |
| Total | ~4000-9000 |

**Quantitative Analysis**

| | |
|---|---|
| Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years]. | Unknown |

**Threats (actual or imminent, to populations or habitats)**

Shoreline and wetland development, habitat fragmentation and loss, vehicular mortality, introduced predatory fish, depredation by domestic cats and dogs and escaped ranch mink, deliberate persecution, small population effects

**Rescue Effect (immigration from outside Canada)**

| | |
|---|---|
| Status of outside population(s)? N/A | |
| Is immigration known or possible? | No |
| Would immigrants be adapted to survive in Canada? | N/A |
| Is there sufficient habitat for immigrants in Canada? | N/A |
| Is rescue from outside populations likely? | No |

**Status History**

**COSEWIC:** Designated Threatened in May 2002. Status re-examined and confirmed in November 2012.

**Status and Reasons for Designation**

| Status: | Alpha-numeric code: |
|---|---|
| Threatened | C2a(i) |

**Reasons for designation:**

Recent extensive survey efforts to quantify the abundance and distribution of this cryptic and hard to identify snake confirm that it is rare and has a very small distribution. However, little is known about population trends. Fluctuations in population numbers and a continuing decline in overall numbers of mature individuals are suspected; both increase the susceptibility to stochastic events. Shoreline development and its associated risk is an increasing threat throughout much of the range.

**Applicability of Criteria**

**Criterion A** (Decline in Total Number of Mature Individuals):
Not applicable.

**Criterion B (Small Distribution Range and Decline or Fluctuation):**
Meets Endangered B1b(iii)+2b(iii), but does not meet "a" as there is no evidence for severe fragmentation and the number of locations is > 10

**Criterion C (Small and Declining Number of Mature Individuals):**
Meets threatened C2a(i) as there are likely < 10,000 mature individuals, there is an inferred decline from loss and degradation of habitat, and no population has > 1000 mature individuals.

**Criterion D** (Very Small or Restricted Total Population):
Not applicable.

**Criterion E** (Quantitative analysis):
Not done.

## TECHNICAL SUMMARY - Great Lakes population

*Thamnophis sauritus*
Eastern Ribbonsnake
Great Lakes population
Range of occurrence in Canada: Ontario, Quebec

Couleuvre mince
Population des Grands Lacs

**Demographic Information**

| | |
|---|---|
| Generation time | ~ 4-6 yrs |
| Is there an [observed, inferred, or projected] continuing decline in number of mature individuals? | Inferred (due to scale of habitat loss) |
| Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations] | Unknown |
| [Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations]. | Unknown |
| [Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations]. | Unknown |
| [Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10 years, or 3 generations] period, over a time period including both the past and the future. | Unknown |
| Are the causes of the decline clearly reversible and understood and ceased? | Unknown |
| Are there extreme fluctuations in number of mature individuals? | Unknown, but not likely |

**Extent and Occupancy Information**

| | |
|---|---|
| Estimated extent of occurrence | 186 200 km² |
| Index of area of occupancy (IAO)<br>(Always report 2x2 grid value). | 2160 km² |
| Is the total population severely fragmented? | Unknown |
| Number of locations* | Unknown |
| Is there an [observed, inferred, or projected] continuing decline in extent of occurrence? | No |
| Is there an [observed, inferred, or projected] continuing decline in index of area of occupancy? | Unknown |
| Is there an [observed, inferred, or projected] continuing decline in number of populations? | Unknown |
| Is there an [observed, inferred, or projected] continuing decline in number of locations*? | Unknown |
| Is there an [observed, inferred, or projected] continuing decline in [area, extent and/or quality] of habitat? | Yes – observed and projected decline in area of habitat |
| Are there extreme fluctuations in number of populations? | No |
| Are there extreme fluctuations in number of locations*? | No |
| Are there extreme fluctuations in extent of occurrence? | No |
| Are there extreme fluctuations in index of area of occupancy? | Unknown, but not likely |

* See Definitions and Abbreviations on COSEWIC website and IUCN 2010 for more information on this term.

**Number of Mature Individuals (in each population)**

| Population | N Mature Individuals |
|---|---|
| Great Lakes Population | Unknown |
| Total | Unknown |

**Quantitative Analysis**

| | |
|---|---|
| Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years]. | Unknown |

**Threats (actual or imminent, to populations or habitats)**

Wetland loss, shoreline development, vehicular mortality

**Rescue Effect (immigration from outside Canada)**

| Status of outside population(s)? | |
|---|---|
| Is immigration known or possible? | Possible |
| Would immigrants be adapted to survive in Canada? | Probably |
| Is there sufficient habitat for immigrants in Canada? | Unknown |
| Is rescue from outside populations likely? | No |

**Status History**

**COSEWIC:** Designated Special Concern in May 2002. Status re-examined and confirmed in November 2012.

**Status and Reasons for Designation**

| **Status:** | **Alpha-numeric code:** |
|---|---|
| Special Concern | Not applicable |

**Reasons for designation:**

The Great Lakes population is relatively widespread and appears to be locally abundant in a few sites. However, quantitative data are lacking on population size and trends, and most information is anecdotal and from protected areas. Wetland and shoreline habitat loss and road development continue at an alarming rate within their range and present a significant threat to the species. Unless those losses are reversed, the species is at risk of becoming Threatened. Road mortality and habitat loss are widespread and much of the species' distribution occurs in pockets of habitat surrounded by agricultural land, roads and development.

**Applicability of Criteria**

| |
|---|
| **Criterion A** (Decline in Total Number of Mature Individuals):<br>Not applicable. |
| **Criterion B** (Small Distribution Range and Decline or Fluctuation):<br>Not applicable. Does not meet quantitative criteria. |
| **Criterion C** (Small and Declining Number of Mature Individuals):<br>Not applicable. It seems probable that number of mature individuals > 10,000. |
| **Criterion D** (Very Small or Restricted Total Population):<br>Not applicable. |
| **Criterion E** (Quantitative Analysis):<br>Not done. |

## PREFACE

This status report is an update of the 2002 COSEWIC status report for Eastern Ribbonsnakes (COSEWIC 2002). The initial status report identified lack of knowledge as one of the greatest difficulties for the conservation of both the Atlantic and Great Lakes populations of the species.

Since 2002, there have been a number of studies conducted on the Eastern Ribbonsnake, almost all on the Atlantic population (Harwood 2005; Imlay 2009; Saroli 2009; Parks Canada 2012). Knowledge has been obtained on seasonal movement patterns, habitat use, microhabitat selection, location of hibernacula, morphology and behaviour. In the Atlantic population, the number of known locations has increased considerably, primarily by increased search effort filling in gaps within the previously identified range. The known extent of occurrence has almost doubled primarily because of discoveries of a few outlying locations northeast and northwest of the original known range. In the Great Lakes population, the known extent of occurrence has expanded to include extreme southern Quebec and an outlying location east of Cartier. These increases reflect increased knowledge of the extent of occurrence; there is no evidence that they represent an actual range expansion by the species.

Despite the additional studies and increased knowledge, much remains unknown about the status of Eastern Ribbonsnakes in Canada. The full extent of occurrence and area of occupancy remain unknown. Although Eastern Ribbonsnakes are less patchily distributed in the Atlantic population than originally thought, it is still not known if they move among sites. In the Great Lakes population, the level of habitat fragmentation has not been documented. Most importantly, population size and trends are poorly understood in both populations. These knowledge gaps restrict our ability to recognize population trends. Modest fluctuations in abundance may occur and make estimation of population trends difficult.

Both populations continue to face increasing threats from human development as identified in Smith (2002). Habitat fragmentation, high road density and wetland loss are particularly severe in southern Ontario. Development of shoreline habitat is increasing in the ranges of both populations, particularly from cottage and residential development. The cumulative effects of these developments can include decreased, degraded and fragmented habitats, more road development and higher traffic density leading to increased road mortality, increased persecution by people, higher levels of depredation particularly from "subsidized" predators, domestic pets, and increased likelihood of the introduction of exotic species.

## COSEWIC HISTORY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5, 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

## COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

## COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

## DEFINITIONS
## (2012)

| | |
|---|---|
| Wildlife Species | A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years. |
| Extinct (X) | A wildlife species that no longer exists. |
| Extirpated (XT) | A wildlife species no longer existing in the wild in Canada, but occurring elsewhere. |
| Endangered (E) | A wildlife species facing imminent extirpation or extinction. |
| Threatened (T) | A wildlife species likely to become endangered if limiting factors are not reversed. |
| Special Concern (SC)* | A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats. |
| Not at Risk (NAR)** | A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances. |
| Data Deficient (DD)*** | A category that applies when the available information is insufficient (a) to resolve a species' eligibility for assessment or (b) to permit an assessment of the species' risk of extinction. |

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.

** Formerly described as "Not In Any Category", or "No Designation Required."

*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994. Definition of the (DD) category revised in 2006.

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The Canadian Wildlife Service, Environment Canada, provides full administrative and financial support to the COSEWIC Secretariat.

# COSEWIC Status Report

on the

# Eastern Ribbonsnake

*Thamnophis sauritus*

Atlantic population
Great Lakes population

**in Canada**

2012

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## WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

### Name and Classification

Class: Sauropsida
Order: Squamata
Family: Colubridae
Genus: *Thamnophis*
Species: *Thamnophis sauritus*
Common name: English - Eastern Ribbonsnake
French - Couleuvre mince

The Eastern Ribbonsnake (*Thamnophis sauritus*) has four recognized subspecies: Common (*T. s. sauritus*), Peninsula (*T. s. sackenii*), Blue Stripe (*T. s. nitae*) and Northern (*T. s. septentrionalis*) (Behler and King 1979). Of these, only the Northern Ribbonsnake occurs in Canada (COSEWIC 2002). The Eastern Ribbonsnake is one of 30 species in the genus *Thamnophis;* six of which occur in Canada (Rossman *et al.* 1996).

The term "Ribbonsnake" is also written as "Ribbon Snake". The one-word version is the recognized standard in Crother (2008). Both terms are used in scientific literature and on public websites. The term "Ribbonsnake" is consistent with the species' current listing under the *Species at Risk Act* (SARA), Nova Scotia *Endangered Species Act* (NS ESA) and the provincial *Endangered Species Act, 2007* in Ontario (ESA).

### Morphological Description

The Eastern Ribbonsnake is small (460-862 mm), slender, and semi-aquatic, with a long slender tail (Harding 1997). The species can be identified by its black body with one dorsal and two lateral, prominent, yellow stripes extending along the body (Figure 1). The lateral stripes occur on the 3rd and 4th scale rows (Harding 1997), below which the scales are caramel brown (Gilhen 1984) to rust in colour. The ventral scales are cream-coloured. There is a small but distinct vertical white line immediately in front of the eye (preocular scale) (Logier 1967; Harding 1997).

Figure 1. Eastern Ribbonsnake showing the prominent yellow stripes and white line in front of the eye (Photographer: Jeffie McNeil).

In Canada, the Eastern Ribbonsnake may be confused with the Common Gartersnake (*Thamnophis sirtalis*), which occurs throughout the Eastern Ribbonsnake's range, and Butler's Gartersnake (*Thamnophis butleri*), which is restricted to a few areas in southern Ontario (COSEWIC 2002; COSEWIC 2010). Both gartersnake species also have three yellowish longitudinal stripes down their body. However, the lateral stripes on the Common Gartersnake occur on the 2$^{nd}$ and 3$^{rd}$ scale rows, and are often not as bright as those on the Eastern Ribbonsnake. The lateral stripes on Butler's Gartersnake are centered on the 3$^{rd}$ scale row and extend into the 2$^{nd}$ and 4$^{th}$ scale rows (COSEWIC 2010). Eastern Ribbonsnakes are typically more slender than either species of gartersnake and have a longer tail, which is usually about one third of total body length (Gilhen 1984; Rossman *et al.* 1996).

**Population Spatial Structure and Variability**

Spatial structure and genetic variability within populations of the Eastern Ribbonsnake are unknown. In Nova Scotia, Harwood (2005) found no evidence of genetic differences between two locations, whereas McLaughlin (2008) found limited genetic variation among four locations in Nova Scotia, suggesting that there may be some restriction in gene flow among populations. However, both studies had small sample sizes (36 and 46 snakes respectively) and examined only two or one microsatellite loci respectively.

No range-wide genetic studies have been conducted on Eastern Ribbonsnakes and it is not known if the Atlantic population has diverged significantly from other populations of the species. However, analysis of a single microsatellite locus of DNA samples from three Eastern Ribbonsnakes from Nantucket, Massachusetts, and 43 Eastern Ribbonsnakes from Nova Scotia indicated possible genetic differentiation. The Nantucket samples had only one allele at this locus and it was different from all five alleles found in the Nova Scotia samples at the same locus (McLaughlin 2008). Because sample sizes were so small, conclusions from this study are limited.

**Designatable Units**

There are two geographically separated designatable units (DUs) of Eastern Ribbonsnakes in Canada: an Atlantic DU and a Great Lakes DU (COSEWIC 2002). The Great Lakes DU occurs in southern Ontario and extreme southern Quebec and is contiguous with the species' main range in the USA. The Atlantic DU is restricted to southwest Nova Scotia and is isolated from the closest population in Maine by over 300 km (straight line) and over 700 km by land. The Atlantic population is likely a climatic relict that was isolated in Nova Scotia at the end of the warm Hypsithermal period ~5000 years ago (Bleakney 1958; Cook 1993; COSEWIC 2002).

The Eastern Ribbonsnake designatable units are discrete because there is a natural disjunction between two portions of the species' geographic range in Canada, and the two DUs occupy different eco-geographic regions (McAlpine 2010). Because hundreds of kilometres separate the two DUs, there is no possibility of dispersal between them. Additionally, because of the isolation of the Atlantic DU, there is no chance of dispersal from other populations in the USA. Peripheral populations, such as the Atlantic population of Eastern Ribbonsnakes, are often significant evolutionary units of a species (Lessica and Allendorf 1995) and due to its unique ecological setting, the Atlantic population may have developed local adaptations. The loss of either of these two discrete populations would result in an extensive gap in the Canadian range.

**Special Significance**

Eastern Ribbonsnakes in Canada occur at the northern limits of the species' range, which may be significant if the species' range shifts due to climate change. The Nova Scotia population is geographically isolated from the species' main range and has likely been isolated since the last warm period ~5000 years ago (COSEWIC 2002). Peripheral populations such as these may display local adaptations and are often important evolutionary units (Lessica and Allendorf 1995).

No ATK was available for this species.

## DISTRIBUTION

### Global Range

Eastern Ribbonsnakes range from southern Canada to Florida, east of the Mississippi River (Ernst and Barbour 1989). There are also reports of the species in the Bahamas, but it is not known if they are established there (IUCN 2011; NatureServe 2011). The Northern Ribbonsnake subspecies is found contiguously in Ontario, extreme southern Quebec, Michigan, Indiana, Illinois, Ohio, Pennsylvania, New York, Vermont, New Hampshire and Maine with isolated populations occurring in Nova Scotia and Wisconsin (COSEWIC 2002, NatureServe 2011) (Figure 2). In the main range in the United States, the subspecies often intergrades with the Common Ribbonsnake (*T. sauritus sauritus*) (COSEWIC 2002).

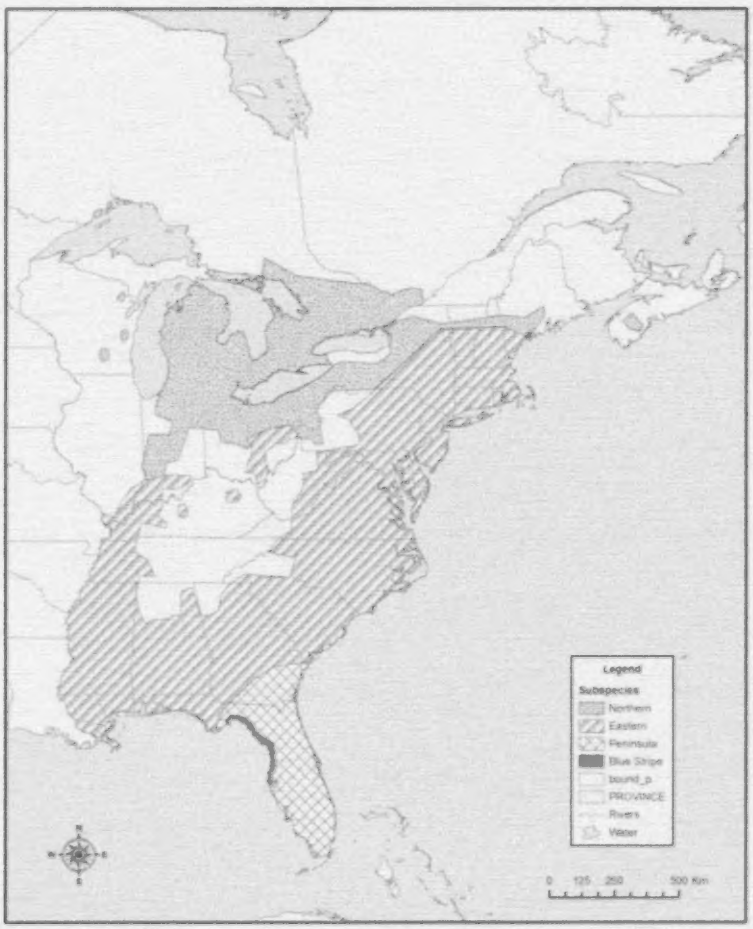


Figure 2. Global range of the Eastern Ribbonsnake (adapted from COSEWIC 2002). Note that the "eastern" subspecies is now called the "common" subspecies *T. s. sauritus* (Crother *et al.* 2008)

## Canadian Range

In Canada, Eastern Ribbonsnakes are found in southern Ontario, extreme southern Quebec and southwest Nova Scotia, all below 47 degrees latitude (Figure 3). Approximately 5 % of the global range of the Eastern Ribbonsnake occurs in Canada as does 20 % of the range of the Northern Ribbonsnake subspecies.

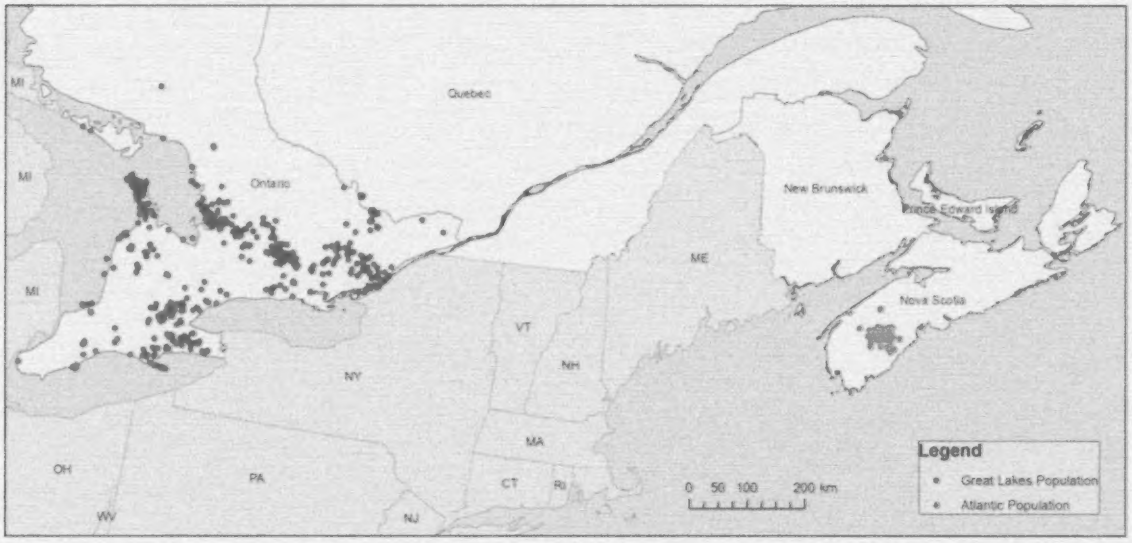


Figure 3. Observations of Eastern Ribbonsnakes in Canada's Great Lakes and Atlantic populations (Note: The observations mapped for the Great Lakes population include all records supplied by NHIC and include records that have not been verified by photographs, specimens or other review).

### Atlantic Population

The Atlantic Population of Eastern Ribbonsnakes appears to be limited to southwest Nova Scotia. The majority of sightings are on the Mersey and Medway watersheds, although confirmed reports also exist on the LaHave, Petite Rivière and Annapolis watersheds (Gilhen *et al.* in press). The extent of occurrence (EO) in Nova Scotia encompasses approximately 2931 $km^2$ and the index of area of occupancy (IAO) is approximately 332 $km^2$. Within that range, Eastern Ribbonsnakes have been found at 46 sites (lakes or brooks). The majority of the sites are in the central part of the two primary watersheds, with a few sites on the outer edges of the known range (Figure 3). The known EO in the Atlantic population has increased considerably since the publication of the 2002 status report (COSEWIC 2002), due to the discovery of new sites resulting from increased search effort. There is no evidence to indicate that the species' range in Nova Scotia has expanded or contracted considerably over the past three generations (12-18 years).

The Atlantic population contains approximately 26 locations for Eastern Ribbonsnakes. The number of locations was calculated based on different scales of primary threats to Eastern Ribbonsnakes in Nova Scotia. First, on the scale of individual waterbodies or cluster of waterbodies in one geographic area, there are degrees of housing development, agriculture and forestry practices with their associated habitat loss and degradation, increase in roads and traffic and increase in encounters with pets and people tend to occur. At this scale, lakeshore habitats tend to be more at risk from cottage and residential development, whereas stream habitats tend to be more at risk from forestry practices. Threats on a larger watershed scale originate with activities such as water level alteration, the introduction of exotic predatory fish and construction of hydroelectric dams. Sites primarily on private lands face a different level of threats than those inside protected areas or those primarily on provincial Crown lands. Taking the scales of threats into account, each designated location of Eastern Ribbonsnakes includes sites with similar habitats in close geographic proximity, occurring on the same watershed and with the same water level regime, and having similar land ownership and protection status.

Great Lakes Population

The Great Lakes population extends from the tip of southern Ontario to the Ottawa River, with just 18 sightings reported north of the Ottawa River in Quebec (Desroches and Laparé 2004; Gauthier pers. comm. 2012). The northern range of the known population extends from Alexandria in eastern Ontario to Manitoulin Island in the west (Figure 3). Eastern Ribbonsnakes are reported in 40 counties/districts in Ontario (Table 1). In Quebec, all 18 observations occurred along a 30-km stretch of the Ottawa River, from Bristol to Portage-du-Fort (Gauthier, pers. comm. 2012). The extent of occurrence (EO) is estimated to be approximately 186,200 km² and the index area of occupancy (IAO) is 2,160 km². The EO is larger than previously calculated (COSEWIC 2002) due to an increase in search effort (see **Search Effort** Great Lakes Population), and there is no indication that this increase represents a range expansion for the species. There is also no indication that the range has contracted significantly over the past three generations, although the lack of survey effort would hamper the ability to detect a contraction in range.

**Table 1. Number of sightings recorded per district in Ontario (NHIC database 2011, updated from COSEWIC 2002). ***

| District | Year First Reported | Year Last Reported | Total Records |
|---|---|---|---|
| BRANT | 1966 | 2008 | 36 |
| BRUCE | 1960 | 2011 | 325 |
| DUFFERIN | 1997 | 1997 | 1 |
| DURHAM | 1968 | 1968 | 1 |
| ELGIN | 1949 | 1988 | 3 |
| ESSEX | 1992 | 1992 | 1 |
| FRONTENAC | 1930 | 2009 | 40 |

| District | Year First Reported | Year Last Reported | Total Records |
|---|---|---|---|
| GREY | 1938 | 2009 | 58 |
| HALDIMAND-NORFOLK | 1933 | 2008 | 56 |
| HALIBURTON | 1988 | 2008 | 11 |
| HALTON | 1977 | 2008 | 22 |
| HAMILTON-WENTWORTH | 1950 | 1991 | 10 |
| HASTINGS | 1988 | 2005 | 11 |
| HURON | 1980 | 2002 | 9 |
| KENT | 1933 | 2009 | 66 |
| LAMBTON | 1970 | 1993 | 17 |
| LANARK | 1954 | 1996 | 19 |
| LEEDS & GRENVILLE | 1944 | 2010 | 76 |
| LENNOX & ADDINGTON | 1951 | 1991 | 12 |
| MANITOULIN | 1984 | 2005 | 2 |
| METROPOLITAN TORONTO | 1858 | 1931 | 5 |
| MIDDLESEX | 1933 | 2008 | 8 |
| MUSKOKA | `1969 | 2010 | 60 |
| NIAGARA | 1968 | 2005 | 32 |
| NORTHUMBERLAND | 1985 | 1988 | 12 |
| OTTAWA-CARLETON | 1978 | 1978 | 2 |
| OXFORD | 1940 | 1985 | 2 |
| PARRY SOUND | 1965 | 2009 | 9 |
| PEEL | 1969 | 1990 | 4 |
| PETERBOROUGH | 1924 | 2010 | 90 |
| PRESCOTT & RUSSELL | 1989 | 1989 | 2 |
| PRINCE EDWARD | 1979 | 1979 | 1 |
| RENFREW | 1990 | 1993 | 5 |
| SIMCOE | 1979 | 2010 | 11 |
| STORMONT DUNDAS & GL | 1989 | 1989 | 1 |
| SUDBURY | 2005 | 2005 | 2 |
| VICTORIA | 1982 | 2010 | 27 |
| WATERLOO | 1924 | 1991 | 23 |
| WELLINGTON | 1904 | 1990 | 30 |
| YORK | 1928 | 1984 | 3 |

* As the majority of records in the NHIC database result from incidental observations, rather than directed surveys, presence/absence within a district should not be inferred from a lack of current or historical records.

## Search Effort

Atlantic Population

Systematic efforts to study Eastern Ribbonsnakes in the Atlantic Population have been underway since 2004. The Eastern Ribbonsnake Recovery Team adopted a two-pronged approach to filling critical knowledge gaps: 1) distribution surveys to increase knowledge of the species' range in Nova Scotia and 2) mark-recapture surveys at specific locations to identify seasonal habitat use and document movements and population trends (McNeil 2005, Herman and McNeil 2005). Survey effort has been recorded for all projects targeting Eastern Ribbonsnakes, although additional Eastern Ribbonsnake sightings have been recorded from researchers working on other projects and from the public.

Distribution surveys occurred both within and around the known range of the species. Survey areas were selected based on historical data and public sighting reports, proximity to known sites, accessibility and habitats identified by aerial photographs, as well opportunities afforded during other fieldwork. Selected wetlands were visually surveyed for Eastern Ribbonsnake by one or more observers. Since 2009, trained dogs also have proven useful in locating Eastern Ribbonsnakes (Gadbois *et al.* 2009). Attempts were made to hand capture all Eastern Ribbonsnakes seen, and detailed location and morphological data were recorded. In all, over 1400 person-hours were expended at 99 waterbodies (lakes and/or brooks) from 2004 to 2011, resulting in approximately 300 observations. A disproportionate number of these observations (222) occurred at only four sites (Nova Scotia Ribbonsnake Recovery Team 2011).

Figure 4 provides an overview of the areas in Nova Scotia surveyed for Eastern Ribbonsnakes and identifies those that yielded Eastern Ribbonsnake captures. Each site square represents a lake or brook; the size of the site was not standardized. Effort varied considerably among areas; many of the sites with higher effort were repeatedly visited once Eastern Ribbonsnakes were found. In all, Eastern Ribbonsnakes were found in 27 of the 99 sites surveyed and in an additional 19 sites through incidental sightings.

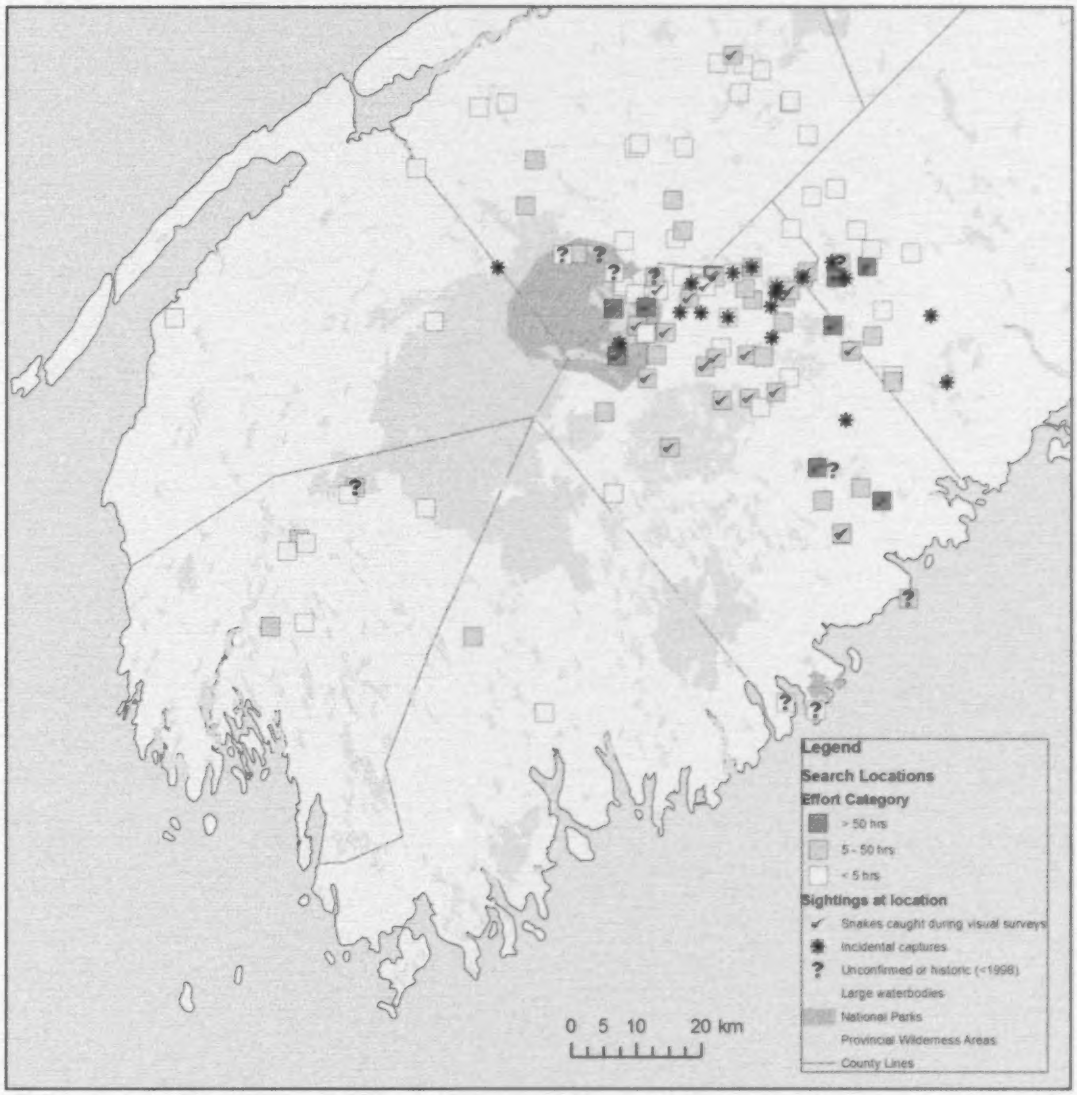


Figure 4. Overview of Eastern Ribbonsnake search effort and success from 2004-2011 in Nova Scotia. Each square represents a waterbody (e.g., lake, stream or brook).

Great Lakes Population

Eastern Ribbonsnakes are one of Ontario's least studied reptile species at risk (Oldham, pers. comm. 2011). There are few data on range-wide search efforts, although there have been smaller-scale studies as described below. On a larger scale, Ontario data are maintained by the Natural Heritage Information Centre (NHIC). The Ontario Herpetofaunal Atlas collected observational data from volunteers and also collated historical data from 1984 to 2000 (Oldham and Weller 2000). In 2009, Ontario Nature developed a new Ontario Reptile and Amphibian Atlas (Ontario Nature 2011). Both atlases record Eastern Ribbonsnake observations, but contain few data on survey effort (NHIC Database 2011).

In Quebec, Eastern Ribbonsnake sightings are recorded in the l'Atlas des amphibiens et des reptiles du Québec (Centre de données sur le patrimoine naturel du Québec 2011). No professional surveys have been conducted to determine the distribution of ribbonsnakes in Quebec. Dedicated search effort is low and sightings have been primarily reported by amateur herpetologists or through anecdotal observations during Blanding's Turtle research (Gauthier, pers. comm. 2012)

The Hamilton Herpetofaunal Atlas conducted active surveys for reptiles and amphibians from 1987 to 1992 in the Hamilton area and also incorporated historical data (Lamond 1994). The study area (40-km radius) was divided into 2 km x 2 km squares for surveying. Each square was systematically surveyed for reptiles and amphibians by searching ponds and streams, turning logs, and walking woodlots, swamp edges and roads. The search teams also contacted landowners and encouraged them to submit records. They found that Eastern Ribbonsnakes had a restricted range within the study area, with sightings in just 4.6% of all squares surveyed (52 of 1130).

Studies have also been conducted in a number of protected areas. As part of a study of microhabitat selection, Patterson (2009) surveyed a small (3.8 ha) wetland outside of MacGregor Point Provincial Park 3-5 times per week from late April to late August 2008, resulting in 46 Eastern Ribbonsnake observations (Paterson 2009). Reptile and amphibian inventories were conducted in the 1980s in Bruce Peninsula National Park and in the Tobermory Islands (the latter of which are now part of Fathom Five National Marine Park) (Schueler 1984, Haselmayer pers. comm. 2011). Only two observations of Eastern Ribbonsnakes were recorded in the Tobermory Island surveys (Schueler 1984); since that time no confirmed records of Eastern Ribbonsnakes have occurred at Fathom Five National Marine Park (Haselmayer pers.comm. 2011).

In 2008, targeted surveys for ribbonsnakes were carried out in six Ontario Nature Reserves in Grey and Bruce counties as well as several other areas throughout the northern Bruce Peninsula (Crowley 2009). At a site in Grey County, between 3 and 10 ribbonsnakes were often documented with only 15-20 minutes of search effort (Crowley pers. comm. 2012). Although locally abundant at this site, habitat in Grey County appears to be limiting and the species is probably quite rare (never encountered at

other sites or on roads; Crowley pers. comm. 2012). However, this species is somewhat more abundant on the northern Bruce Peninsula, occurring in most wetland and shoreline habitats that were surveyed (Crowley pers. comm. 2012). At some sites that were surveyed repeatedly (such as Singing Sands within Bruce Peninsula National Park), ribbonsnakes were regularly encountered. Occasionally, individuals were found several hundred metres from permanent water sources, although the vast majority of observations were within 20 m of a wetland or shoreline (Crowley 2009).

Eastern Ribbonsnakes were one of the secondary target species identified in an inventory of species at risk associated with riparian habitats that was conducted in the Bruce Peninsula from 2006-2008 (Jalava 2009). Search areas were selected based on air photos, satellite imagery and topographic maps. Surveys primarily involved walking searches looking for target species. Attempts were also made to capture snakes using cover boards, funnel traps and road surveys while driving to sites. In all, 55 Eastern Ribbonsnakes were encountered throughout the area over the 3-year period, with an observation rate of slightly more than 1 observation per 2 person-days of fieldwork (Jalava 2009).

Extensive surveys of the Long Point National Wildlife Area were conducted from 1996-1999 and in 2004 resulting in a total of 13 and 9 observations respectively (Gillingwater and Piraino 2004, 2005). Road mortality surveys along the Long Point Causeway adjacent to the Big Creek National Wildlife Area were carried out sporadically from 2003 to 2008 and on a consistent basis from 2008 to 2011, resulting in 31 Eastern Ribbonsnakes observed killed along the Causeway (Long Point Causeway Improvement Project unpubl. data). Additional surveys within the Crown Marsh (Long Point region) in 2009 and within the Big Creek National Wildlife Area (2003 - 2011) have resulted in 7 (6 adult, 1 juvenile) and 5 (all adult) live observations respectively (Gillingwater unpubl. data). Eastern Ribbonsnakes appear to be uncommon in the Long Point area, but do persist in small numbers near lake, marsh and dune habitats (Gillingwater pers. comm. 2012).

Eastern Ribbonsnakes are also occasionally encountered incidental to studies of other species. Cover boards targeting Massasaugas (*Sistrurus catenatus*) in 2008 in Bruce Peninsula National Park and Fathom Five Marine National Parks resulted in the capture of seven Eastern Ribbonsnakes in 4262 board-checks (Harvey 2008).

## HABITAT

### Habitat Requirements

Eastern Ribbonsnakes are semi-aquatic and found in a variety of wetland habitats with both flowing and standing water including marshes, bogs, fens, ponds, lake shorelines and wet meadows (Behler and King 1979; Ernst and Barbour 1989). They are sometimes found in vernal pools and moist woods (Conant 1938). They can also be found along beach, dune and slough habitats (Gillingwater pers. obs). In Nova Scotia,

Beaver (*Castor canadensis*) activity is seen at many sites containing Eastern Ribbonsnakes, and Beaver dams may help maintain appropriate habitat (Parks Canada 2012). Disturbance levels and seral stages of habitat succession may play a significant role in local abundance of Eastern Ribbonsnakes, although these factors are not well understood (Parks Canada 2012).

Most sightings of Eastern Ribbonsnakes outside of the overwintering period occur near water's edge (Behler and King 1979). However, even during summer, Eastern Ribbonsnakes are occasionally located in upland meadows, upland forest and dune habitats, sometimes relatively far from water (Logier 1967; Harding 1997). Snakes may move away from water to give birth (Harding 1997), shed (Urquhart pers. comm. 2011), or seek cover.

Within wetland habitats, Eastern Ribbonsnakes are often found in clumps of grasses or sedges and low shrubbery (Harding 1997), beneath natural and anthropogenic cover items (Gillingwater and Piraino 2004, 2005), in damp areas at the margins of streams and ponds (Logier 1967), and around shallow pools and side channels (Desroches and Laparé 2004; Parks Canada 2012). They have been observed on Beaver lodges and dams (Bleakney 1951; Desroches and Laparé 2004; NS Ribbonsnake Database 2011). In Quebec, most sightings were observed near water in areas of bare substrate composed of gravel, pebbles, cobbles and boulders, on beaver lodges, and in an abandoned agricultural field partly flooded by a beaver dam (Gauthier pers. comm. 2012).

In Ontario, ribbonsnakes appear to select microhabitats suitable for behavioural thermoregulation, foraging, and predator avoidance (Patterson 2009). They have frequently been observed climbing shrubs or trees (Carpenter 1952b; Logier 1967; Crowley pers. comm. 2012). Seasonal shifts in habitat use within wetlands are also apparent (McNeil 2005; Imlay 2009; Saroli 2009).

Individual Eastern Ribbonsnakes appear to have a relatively small home range within their wetland habitats (Ernst and Barbour 1989). In Nova Scotia, Bell *et al.* (2007) found that radio-tagged Eastern Ribbonsnakes rarely moved more than 10 m. However, this estimate is likely low as all snakes in the study were gravid females and the snakes' movements may have been influenced by the implanted transmitters (Bell *et al.* 2007). Based on mark-recapture data, both Imlay (2009) and Saroli (2009) documented longer movements at two sites in Nova Scotia. Maximum movement observed was 391 m, and home range estimates for eight Eastern Ribbonsnakes ranged from 1608 $m^2$ to 7784 $m^2$ (Imlay 2009; Saroli 2009).

Overwintering

Eastern Ribbonsnakes spend winter in underground hibernacula where they must avoid freezing and desiccation (Carpenter 1953; Costanzo 1989). They may hibernate in well-drained sites or in areas close to water (Harding 1997) and may even be completely submerged inside their hibernacula (Carpenter 1953; Todd *et al.* 2009).

Eastern Ribbonsnakes have been reported or suspected of overwintering in a variety of sites such as dens in grassy pastures (Rossman *et al.* 1996), ant mounds, vole tunnels and crayfish burrows (Carpenter 1953), Muskrat *(Ondatra zibethicus*) lodges (Ernst and Barbour 1989), and underground tunnels at rocky forested sites (NS Ribbonsnake Recovery Team 2011) and rocky areas at wetland peripheries.

Although at least some snakes probably remain within the wetland boundaries to overwinter (Bell *et al.* 2007; Todd 2007), there is increasing evidence that snakes in Nova Scotia may move considerable distances from water to winter in forested areas (Imlay 2009; NS Ribbonsnake Recovery Team 2011). One hibernation area has been located adjacent to Grafton Lake, Kejimkujik National Park and National Historic Site, 150 m from the nearest wetland. At least a dozen sightings elsewhere in Nova Scotia in early spring and late fall suggest use of upland hibernacula is not limited to Grafton Lake (Imlay 2009; NS Ribbonsnake Recovery Team 2011). In southwestern Ontario, Eastern Ribbonsnakes emerged from a communal hibernaculum in upland forest habitat, within 30 m of a forested wetland (Gillingwater, pers. obs.). The full extent of movements by snakes to their hibernacula is not known.

**Habitat Trends**

Atlantic Population

Loss of shorelines and wetlands is a significant concern for the Atlantic population, although the rates of wetland loss in most of Nova Scotia have not been systematically characterized (Nova Scotia Environment 2011a). Shoreline development is a particular concern as the number of cottages and homes on lakeshores is presently increasing. In the Tusket watershed (in southwest Nova Scotia west of known Eastern Ribbonsnake occurrence) residential development on 13 lakes increased by 363% over 55 years, with the potential to increase by another 100% (Eaton and Boates 2002). Additionally, an average of 13% of wetlands had been lost at eight of these lakes over the same period. Although a comparable analysis has not been conducted on the Mersey and Medway watersheds, it is likely that the trends found in the Tusket study are representative of many of the lakes where Eastern Ribbonsnakes occur. There are over 7900 private landowners within the range of the Eastern Ribbonsnake occurrence in Nova Scotia. At two of the larger lakes with Eastern Ribbonsnakes, Ponhook and Molega, the number of individual lakefront properties has increased by approximately 20% from 2002 to 2010, presumably reflecting subdivision for development (Mersey Tobeatic Research Institute, unpubl. data).

Great Lakes Population

Habitat loss, fragmentation and degradation are ongoing within the range of the Great Lakes population. Wetland loss is particularly high in southern Ontario. Recent GIS analysis determined that over 72% of the original wetlands (prior to European settlement) over 10 ha in size in southern Ontario were lost to development by 2002 (Ducks Unlimited 2010). This decline is most dramatic in southwestern Ontario, parts of

eastern Ontario, and the Niagara and Toronto areas where over 85% of pre-European settlement wetlands were lost due to urban, agricultural and forestry development by 2002 (Ducks Unlimited 2010). Shoreline development is also a concern. In Ontario over 80% of the Great Lakes shoreline is privately owned. Approximately 40 % of the Canadian Great Lakes shoreline is residential, 32 % forested and 17 % agricultural (Lawrence 1995). Road density in southern Ontario is among the highest in Canada. The number of kilometres of paved roads in southern Ontario increased by over 400 % from 1935 to 1995 to 35,637 km (Fenech *et al.* 2000).

In Quebec, the size and quality of habitat in the places where Eastern Ribbonsnakes have been observed is not at significant risk in the short-term (Giguère pers. comm. 2012) and some of properties where the species has been observed are currently protected by Nature Conservancy Canada (Gauthier pers. comm. 2012).

## BIOLOGY

### Life Cycle and Reproduction

Hibernation and aestivation

Eastern Ribbonsnakes overwinter in underground hibernacula. They require an environment that prevents both freezing and desiccation (Carpenter 1953; Costanzo 1989). They move to their hibernacula in fall and emerge in early spring. In Nova Scotia, the earliest reported active date is March 17 and the latest reported date is November 21 (NS Ribbonsnake Recovery Team 2011). In Ontario, the extreme recorded dates of Eastern Ribbonsnake activity are from March 28 to December 6 (COSEWIC 2002). Snakes emerge in spring shortly after snow cover is gone. In spring 2010 and 2011 in Nova Scotia, Eastern Ribbonsnakes remained near a wooded overwintering site for approximately 2 weeks before they disappeared, presumably returning to their summer wetlands (NS Ribbonsnake Recovery Team 2011). They appear to hibernate communally in small groups (Carpenter 1953; NS Ribbonsnake Recovery Team 2011).

During hot, dry periods, Eastern Ribbonsnakes may aestivate (Ernst and Barbour 1989), although this has not been documented in Canadian populations. In Nova Scotia, capture frequency often decreases in mid-summer. This decrease is partly due to reduced detectability as vegetation grows, and some snakes may retreat undercover or underground during hot periods. On a hot June day in 2010, road crews installing a culvert uncovered eight or nine Eastern Ribbonsnakes together under a pile of rocks (NS Ribbonsnake Recovery Team 2011). It is not known how frequently this behaviour occurs or if it represents aestivation.

## Feeding

Eastern Ribbonsnakes feed mostly on amphibians and small fish (Logier 1967; Gilhen 1984; Ernst and Barbour 1989) with tadpoles and small frogs making up the majority of their prey (Gilhen 1984; Brown 1979). Leeches, spiders and caterpillars have also been reported as occasional prey (Hamilton and Pollack 1956; Ernst and Barbour 1989). Several sources note a lack of earthworms in their diet and that snakes in captivity refuse to eat earthworms when offered (Carpenter 1952b; Ernst and Barbour 1989; Rossman *et al.* 1996; Harding 1997). However, Todd (2007) observed neonate Eastern Ribbonsnakes in Nova Scotia feeding on earthworms and Hamilton and Pollack (1956) stated that earthworms were regularly eaten.

Most feeding occurs in morning or early evening, although snakes may also forage at night (Ernst and Barbour 1989). Eastern Ribbonsnakes hunt by both active searching (Carpenter 1952b; Ernst and Barbour 1989) and by sitting poised on shoreline banks overlooking the water (Bell *et al.* 2007). Prey is detected by both sight and smell (Ernst and Barbour 1989). Some scavenging behaviour has been noted; the consumption of a dead fish was observed along an interior wetland in southwestern Ontario (Gillingwater pers. comm. 2012).

Eastern Ribbonsnakes appear to feed throughout the active season and have been encountered with distended stomachs as late as mid-October in Nova Scotia (NS Ribbonsnake Recovery Team 2011). Carpenter (1952b) found that in Michigan feeding modes and prey varied seasonally with amphibian activity.

## Reproduction

Eastern Ribbonsnake courtship and mating generally occur in spring, although fall mating may also occur (Ernst and Barbour 1989, Harding 1997). Snake courtship and mating have occasionally been observed in both Ontario and Nova Scotia. In Ontario, aquatic courtship was observed in April (COSEWIC 2002). In Nova Scotia, Eastern Ribbonsnakes have been observed mating in March and April, shortly after emergence from the hibernacula, both near their overwintering sites and within wetlands (NS Ribbonsnake Recovery Team 2011). Concentrations of adult Eastern Ribbonsnakes in early fall suggest the possibility of fall mating as well (Parks Canada 2012).

Eastern Ribbonsnakes are ovoviviparous, giving birth to live young. Ovulation and gestation are thought to occur in May (Sommerer 2000) and snakes typically give birth from mid-July to mid-September (Milnes 1946; Behler and King 1979; Ernst and Barbour 1989; Sommerer 2000). Newborn young have been found near the water's edge and also in nearby upland habitats (Harding 1997; McNeil 2005). Clutch size varies widely with 2-26 young reported (Behler and King 1979; Rossman *et al.* 1996; Sommerer 2000). An average of 9-12 young per clutch seems to be most common (Harding 1997; Sommerer 2000). Sex ratio at birth is approximately 1:1 (Sommerer 2000). Snout-vent lengths of neonates range from 136 to 170 mm (Sommerer 2000) and total lengths range from 160-240mm (Gilhen 1984; Harding 1997; Todd 2007).

Eastern Ribbonsnakes can reach maturity in their second or third year (Carpenter 1952a; Harding 1997). Carpenter (1952a) reported that the smallest gravid female he encountered was 421 mm snout-vent length. In a Michigan study, the proportion of females breeding in a year ranged from 46% to 65% (Seigel *et al.* 1987).

Growth

Carpenter (1952a) reported that the primary growth period in Michigan was between May and September. This is consistent with observations of shedding snakes and recently shed skins from Nova Scotia, which are usually found from late May-early September (Imlay 2009).

Male neonates are significantly heavier than females, and Eastern Ribbonsnake clutches with heavier offspring are more male-biased (Sommerer 2000). In contrast, adult males are smaller than adult females (Sommerer 2000). Carpenter (1952a) found that both males and females grow rapidly in their first year, but the growth rate of males decreases more rapidly than that of females.

Longevity and generation time

Longevity of Eastern Ribbonsnakes in the wild is largely unknown. Eastern Ribbonsnakes mature and begin reproducing in their second or third year (Carpenter 1952a; Behler and King 1979). Recorded survival in captivity ranges from 4-10 years (Ernst and Barbour 1989; Harding 1997). In Nova Scotia, several marked snakes have been re-captured 2-3 years after their initial capture. Because most were at least 1 year old at the time of first capture, they were at least 3 to 4 years old at the time of last sighting (NS Ribbonsnake Recovery Team 2011). Thus generation time is likely no more than 4-6 years.

**Physiology and Adaptability**

Eastern Ribbonsnakes occur at the northern limit of their range in Canada and may be constrained by temperature and climate. In Nova Scotia, this may restrict their distribution to the southwestern part of the province (Bleakney 1958).

Eastern Ribbonsnakes rely primarily on heat from their surroundings to regulate their body temperatures. Snakes behaviourally thermoregulate to maintain appropriate body temperatures (Carpenter 1956). They may also restrict blood flow to the tail in cold weather to maintain a higher body core temperature (Ameil and Wassersug 2010). They typically bask in exposed sunny spots not far from cover to gain sufficient heat for movement, gestation and digestion. Snakes must also avoid overheating and will take refuge in water, under vegetation, in bushes and underground (Carpenter 1952b, NS Ribbonsnake Database 2011). Snakes will also use natural and anthropogenic cover items such as plywood, tin etc. (Gillingwater and Piraino 2004). Carpenter (1956) found mean cloacal temperature strongly correlated with ground temperature and most often was between 20°C and 30°C.

Eastern Ribbonsnakes display several anti-predator behaviours; they rely on crypsis to blend in with their environment, flee on land to nearby cover, swim, and hide in aquatic vegetation (Gilhen 1984; Schribner and Weatherhead 1995; Harding 1997). When swimming, they usually glide across the water's surface but can also dive (Harding 1997). Conant (1938) noted that in larger waterbodies they are more likely to swim along the shore and hide in vegetation, whereas in smaller ponds and ditches they swim across the water to escape. In a laboratory study of anti-predator behaviour, Eastern Ribbonsnakes responded to threats by tail wagging, direction reversals and strikes (Bowers *et al.* 1993). Tail wagging may be an important mechanism to deflect a predator attack from their heads, and may account for the high number of field reports of Eastern Ribbonsnakes missing parts of their tails (Bowers *et al.* 1993).

**Dispersal and Migration**

Little is known about Eastern Ribbonsnake dispersal. Throughout their range, Eastern Ribbonsnakes are usually patchily distributed and it is not known if they travel between populations. Individual snakes were documented moving a total distance of up to 391 m from April to October at a site in Nova Scotia (Imlay 2009); more extensive movements are suspected but have not been documented. A study of wetlands surrounding a known high density site in Nova Scotia found no Eastern Ribbonsnakes that had been marked in the high density site in surrounding wetlands (Saroli 2009).

Barriers to movements are not known, although Eastern Ribbonsnakes have been observed travelling through a variety of habitats including roads, lawns, gravel pits, forests and meadows (Harding 1997; NS Ribbonsnake Database 2011). Large highways with high traffic volume have been shown to be significant barriers to movement for other snake species (Andrews and Gibbons 2005; Rouse *et al.* 2011).

### Interspecific Interactions

Eastern Ribbonsnakes have a variety of predators including wading birds, small mammals, hawks, and other snakes (Ernst and Barbour 1989; Harding 1997). Predators of young snakes also include fish, large crayfish and turtles (Ernst and Barbour 1989). Domestic pets, particularly cats, pose a predation threat (COSEWIC 2002, Parks Canada 2012) as do escaped ranch mink (*Mustela vison*) in Nova Scotia. Eastern Ribbonsnakes rely on amphibians as their primary source of prey and it is likely that Eastern Ribbonsnake abundance is closely tied to prey abundance (Harding 1997, COSEWIC 2002).

Eastern Ribbonsnakes are frequently found at sites with other species of snakes (Lamond 1994). They may hibernate or use cover materials with other species of snakes as well (Carpenter 1953).

## POPULATION SIZES AND TRENDS

### Sampling Effort and Methods

Atlantic Population

The most reliable estimates of population trends come from capture-mark-recapture studies at two sites: Grafton Lake (within Kejimkujik National Park and National Historic Site) and Molega Lake (within a working landscape). These two sites were chosen based on their apparent high abundance of Eastern Ribbonsnakes and may not be representative of trends across the population as a whole. Snakes were marked through scale clipping, which is not permanent and is prone to errors (McNeil 2005) and by pit-tagging, particularly at Molega Lake (Saroli 2009).

At Grafton Lake, abundance of snakes was first estimated in 2001 (Bell *et al.* 2007). Visual surveys have been conducted continuously from 2004 to 2011 although survey effort varied considerably, ranging from a high of 338 h in 2004 to a low of 37 h in 2011 (NS Ribbonsnake Recovery Team 2011). Starting in 2009, trained conservation canines were also used to locate snakes (Gadbois *et al.* 2009). The site at Grafton Lake consists of floodplains on both sides of the lake and has changed considerably during the course of the study, with regeneration of vegetation following removal of a dam in the mid-1990s. Anecdotal evidence suggests that Eastern Ribbonsnake abundance at this site increased in the years immediately following dam removal (Parks Canada 2012).

Molega Lake has a large number of cottages and residential homes. Although there are cottages at the study site, development is less extensive than in many of the areas on the lake. The study site consists of a wetland cove and a 100-m causeway connecting a small island with the mainland (Imlay 2009). The site was studied continuously from 2006-2010, with efforts ranging from 27 hours in 2010 to 290 hours in 2008 (NS Ribbonsnake Recovery Team 2011).

At both sites, survey results are confounded by variations in seasonal and daily timing, water levels, weather conditions, and observer experience.

Great Lakes Population

A number of localized studies have searched for Eastern Ribbonsnakes, as described in the **Search Effort** section above and many of these studies occurred within protected areas. No studies focused specifically on abundance or population estimates, although researchers involved in these studies provided insight on relative abundance (Paterson pers. comm. 2011; Urquhart pers. comm. 2011).

**Abundance**

Atlantic Population

In Nova Scotia, distributional surveys suggest that abundance of ribbonsnakes may vary considerably in the areas in which they occur and that they may not regularly occur in the high densities that are reported elsewhere. The majority of the 46 known sites only have a few sightings each and only five sites have more than 50 observations (Parks Canada 2012). These numbers could partly reflect survey effort as researchers tended to return to sites where Eastern Ribbonsnake abundance appeared to be high. Among the 26 known locations that received at least 5 hours of survey effort, the number of observations per hour of effort ranged from 0.02 to 0.52 (NS Ribbonsnake Recovery Team 2011).

The only estimates of population size are from the 3.5-ha study site at Grafton Lake. Based on mark-recapture surveys in 2001, Bell *et al.* (2007) estimated the survey area at Grafton Lake contained approximately 188 snakes (95% CI = 141-284) using Chao's moment estimator. A similar analysis based on the 2004 sample period estimated 93 adult and juvenile snakes based on the spring sampling period (95% CI 71-139) and 114 snakes based on the fall sampling period (95% CI 85-181) and a combined estimate of 206 snakes (95% CI 168-276). In the 2004 study, spring and fall samples were examined separately due to a concern of double counting snakes whose clip codes had regenerated during the course of the season (McNeil 2005). Both studies used Chao's method to estimate population size despite concerns about violation of key assumptions of a closed population (McNeil 2005).

The overall size of the Atlantic population is unknown. The 2002 COSEWIC status report estimated that there were between 1000 and 3000 mature individuals in the population (COSEWIC 2002). The number of known sites has increased approximately 280% since the 2002 report, but knowledge of abundance remains poor (NS Ribbonsnake Database 2011). An estimate of 4000-9000 individuals reported in the **Technical Summary** reflects the increase in known sites since 2002 but, like the original estimate, has a high degree of uncertainty. Known ribbonsnake sites include approximately 540 ha of wetlands. Assuming that the density at Grafton Lake (as discussed above) is approximately 28-53 individuals / ha and that approximately 2/3 of those are adults, results in a mean estimate of approximately 18-35 mature individuals per hectare at the site having the highest known density in the province. Most known sites in the province anecdotally appear to have much lower densities. Assuming that the Grafton population density is approximately 2-4 times higher than average results in an estimate of 4.5-17.5 adult ribbonsnakes / ha, which if applied uniformly over the 540 ha of occupied wetlands would result in an estimate of 2430-9450 snakes in the currently known range. Clearly, this estimate has a high degree of uncertainty at all stages of the calculation. It is based on an uncertain population estimate on what appears to be an unrepresentative site and is applied over an uncertain range and uniformly across wetlands. That said, it is the best one can do at this stage.

Great Lakes Population

The overall size of the Great Lakes population is unknown. Throughout their range, Eastern Ribbonsnakes appear to be patchily distributed, but sometimes locally abundant, and this pattern appears to be the case in many areas in Ontario (Logier 1967). In the Hamilton Herpetofaunal Atlas surveys, Eastern Ribbonsnakes were only found in 4.9% of the squares surveyed but not abundant (Lamond 1994). They are noted to be locally abundant at sites in Bruce County (Paterson, pers. comm. 2011; Crowley, pers. comm. 2012). In a study site in Leeds and Grenville, Eastern Ribbonsnakes tended to be observed in higher densities in large wetlands and in lower densities in vernal pools and rocky clearings (Urquhart, pers. comm. 2011). Eastern Ribbonsnakes appear to occur in low densities in the Long Point region of southwestern Ontario, including Long Point National Wildlife Area, Big Creek National Wildlife Area, Crown Marsh and along the shoreline of Long Point Bay, adjacent to the Long Point Causeway (Gillingwater and Piraino 2004, 2005; Long Point Causeway Improvement Project unpub. data). Eastern Ribbonsnakes were relatively frequently observed within some parts of Rondeau Provincial Park from 1996-2001, especially in September as they crossed roads back to overwintering sites (Gillingwater pers. obs.). Also, despite 18 years (1994-2011) of dedicated reptile surveys throughout wetland and river sites in Perth, Middlesex and Oxford Counties (Upper Thames River Watershed), no Eastern Ribbonsnakes were observed (Gillingwater pers. comm.), although there is one record from Middlesex (Table 1). These anecdotal observations represent the only information on ribbonsnake abundance in the Great Lakes populations.

## Fluctuations and Trends

Atlantic Population

Little is known about the long-term trends in Eastern Ribbonsnake populations in Nova Scotia. Eastern Ribbonsnakes appear to have disappeared from one site in Nova Scotia, which in the 1980s contained the highest known density of Eastern Ribbonsnakes in the province, with over 40 snakes found in a single day (Gilhen 1984). The habitat at this site has changed dramatically and presumably this change is the cause of the disappearance of this population. Snakes are known to occur in nearby habitats but not at the dense concentrations of the 1980s (Parks Canada 2012). At another site, there are anecdotal reports of abundant Eastern Ribbonsnakes in the past, but current surveys there have yielded only one individual, despite more than 60 hours of survey effort (NS Ribbonsnake Recovery Team 2011).

The studies at Grafton and Molega lakes provide the most reliable recent estimates of population trends. At the Grafton site, the number of observations per hour of effort suggests an overall decline in snake abundance over time at this site (Figure 5). Because this site is changing considerably as it re-vegetates following removal of a dam in the 1990s, caution should prevail when extrapolating this trend to other sites. At Molega Lake, capture success varied considerably during the 5-year sampling period, suggesting a fluctuation either in numbers or in effectiveness of search methodology (Figure 5).

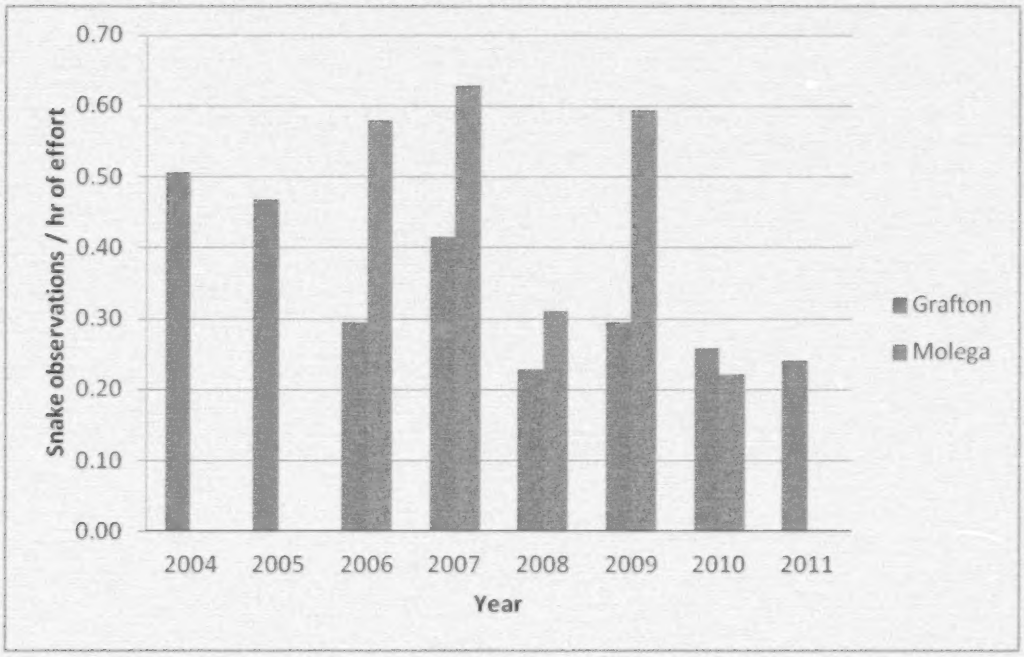


Figure 5. Number of snake observations per unit effort at Grafton and Molega lakes, Nova Scotia.

Great Lakes Population

There are no quantitative data on population fluctuations and trends in the Great Lakes population; however, an overall decline in abundance due to habitat loss can be inferred. In Grey and Bruce observational records are tightly correlated with available habitat (Crowley 2009). All but one observation in these counties occurred in areas where natural shorelines and wetlands persist; ribbonsnakes appear to be locally abundant in some of these areas. In contrast, observations are absent from areas of these counties where forests and wetlands have been converted into vast agricultural tracts (Crowley 2009). The lone observation in the agricultural area occurred in 1981 near a wetland, which may no longer exist (Crowley 2009).

Data from the Natural Heritage Information Centre (2011) show that 20 of the 40 districts in which ribbonsnakes have been reported have not had sighting reports in the last 10 years and 18 districts have fewer than 10 sightings in total (Table 1). However, the majority of the records in the database result from incidental observations, rather than directed surveys, so declines or increases in abundance cannot be inferred from these data.

**Rescue Effect**

There is no chance of a rescue effect for the Nova Scotia population, which is isolated by over 300 km straight-line distance from the nearest population in the main range, and over 700 km by land.

A small possibility exists for Eastern Ribbonsnakes to repopulate Ontario from the United States. Eastern Ribbonsnake populations are considered secure (S5) in neighbouring Michigan and apparently secure (S4) in New York (NatureServe 2011). The potential for immigration and emigration exists in several places, particularly in the area around the Thousand Islands in the St. Lawrence River, where Eastern Ribbonsnakes are known to occur on island sites as well as the mainland on both sides. However, because of the patchy distribution of Eastern Ribbonsnakes and extensive habitat fragmentation (including heavily used roads), any large-scale rescue effect is improbable.

## THREATS AND LIMITING FACTORS

Lack of information for decision making was identified as one of the most significant gaps in the 2002 COSEWIC status assessment (COSEWIC 2002) and this absence remains a significant impediment to assessing status and planning recovery. Although a number of studies have been conducted on Eastern Ribbonsnakes particularly in the Atlantic population since 2002, critical information on population size and trends is still lacking throughout the ribbonsnake's Canadian range. Lack of long-term, quantitative data and knowledge of natural population fluctuations could prevent the recognition of overall population decline, delay implementing recovery actions, and risk initiating actions that may have unanticipated negative effects (Parks Canada 2012, COSEWIC 2002).

Disturbance and seral stages of habitat succession are believed to play a role in ribbonsnake abundance and population trends (Parks Canada 2012). Changes to water levels and seasonal water flow may pose significant threats to ribbonsnakes and can result from installing or removing human-made dams, removing Beaver dams, forestry or agricultural practices and infilling or altering shorelines and wetlands (Parks Canada 2012). Climate change may also alter seasonal water flow patterns (Parks Canada 2012). The overall impacts of climate change on ribbonsnake abundance are not known, and might be positive or negative.

Atlantic Population

The recovery strategy for the Atlantic population of Eastern Ribbonsnakes identified a number of known and potential threats, including: lack of information for decision making, small population effects, alteration of water level and seasonal water flow, habitat degradation, fragmentation and loss, vehicular mortality, introduction of exotic predatory fish, shifts in seasonal temperatures associated with climate change, increased predation associated with human activities and intentional killing and disturbance resulting from increased encounters between humans and snakes (Parks Canada 2012).

The cumulative impact of cottage and residential development along lakeshores and wetlands is probably the most significant threat facing Eastern Ribbonsnakes in Nova Scotia (COSEWIC 2002). As discussed in the **Habitat** section above, lakeshore cottage and residential development in Nova Scotia is increasing; this can lead to habitat fragmentation, degradation and loss, increased road development and traffic frequency, greater likelihood of negative interactions with people, increased depredation by pets, and increased likelihood of introduction of exotic species (Parks Canada 2012). All these may affect both Eastern Ribbonsnakes and their prey. Although no studies have examined the cumulative effects of development on the long-term persistence of Eastern Ribbonsnake populations, several authors did note declines in populations due to habitat loss and development (Ernst and Barbour 1989; Harding 1997).

Direct sources of mortality are not well documented in Nova Scotia and the severity of the threats at the population level is unknown. Sources of incidental mortality include road mortality (on gravel and paved roads and on ATV trails), predation by domestic cats and dogs, and persecution by humans (NS Ribbonsnake Database 2011). All these threats are known from incidental observations, not from targeted surveys or quantitative research so little is known about the frequency and impact of these mortality events.

Introduced Smallmouth Bass (*Micropterus dolomieu*) and Chain Pickerel (*Esox niger*) could also be significant threats to ribbonsnakes in Nova Scotia by reducing the snake's food availability and by eating snakes. Predatory exotic fish, such as these species, have been shown to reduce abundance and diversity of amphibian and small fish species in areas where they are introduced (Vander Zanden *et al.* 2004; Mitchell *et al.* 2011). Both the Smallmouth Bass and Chain Pickerel have been introduced into areas in southwest Nova Scotia and are expanding their range in the province (LeBlanc *et al.* 2011, Mitchell *et al.* 2011).

A new potential threat may come from the thriving mink ranch industry in Nova Scotia. More than 1.5 million mink are currently under cultivation and this number is increasing as the industry is highly profitable (The Globe and Mail, Aug. 17, 2012). Many mink escape and are having an unknown impact on the ecology. Mink are known predators of snakes, and are especially likely to consume ribbonsnakes as the latter are semi-aquatic and thus occupy similar habitat as mink.

Great Lakes Population

Threats facing the Great Lakes population are likely similar to those facing the Atlantic population although the scale of habitat loss and degradation, and frequency of road mortality are much more severe in parts of southern Ontario. As noted in the **Habitat Trends** section above, wetland and shoreline habitat loss is particularly severe in southern Ontario (Ducks Unlimited 2010). Continued habitat loss is a very significant threat with increasing pressure for urban, agricultural, forestry and shoreline development (Ducks Unlimited 2010). This can result in population decline, extirpation of local populations, and increasing population fragmentation (Harding 1997). Even though ribbonsnakes appear to remain locally abundant in areas containing natural shorelines and wetlands, sightings are largely absent from areas that have experienced high levels of habitat loss (Crowley 2009).

High road densities in southern Ontario also pose a considerable threat to both ribbonsnakes and their prey. Road mortality of Eastern Ribbonsnakes is frequently observed, particularly where roads bisect wetland habitats or shorelines (Crowley, pers. comm. 2012). Losses of ribbonsnakes due to road mortality, even within protected areas and areas of relatively low traffic density have been documented (Crowley 2009). A road mortality study on the northern Bruce Peninsula documented 14 dead ribbonsnakes along a set survey route from mid-May to mid-August in 2012 (Tricia Stinnissen, unpublished data 2012); this study did not include the peak spring or fall

migration period when road mortalities may be even higher (Crowley, pers. comm. 2012). Reptile surveys including Eastern Ribbonsnakes were carried out in 2000 and 2001 within Rondeau Provincial Park, including road mortality surveys in 2001. General surveys resulted in repeated Eastern Ribbonsnake sightings throughout some areas of the park, most commonly in May and September. Road mortality surveys in the park were conducted from September 4th to October 25th 2001 and documented 50 deaths, including 46 adults, 3 neonates and 1 unknown age class (Gillingwater, unpub. data).

Amphibians, which Eastern Ribbonsnakes primarily rely on for food, are declining worldwide and face many threats in Ontario, including habitat loss and fragmentation, pollution, emerging infectious diseases, climate change and ozone depletion (Environmental Commissioner of Ontario 2009). Declines in abundance have been documented in several amphibian species in Ontario, including the Spring Peeper (*Pseudacris crucifer*), Jefferson Salamander (*Ambystoma jeffersonianum*), Pickerel Frog (*Lithobates palustris*), Northern Cricket Frog (*Acris crepitans*), Bullfrog (*Lithobates catesbeianus*) and Northern Leopard Frog (*Lithobates pipiens*) (Environmental Commissioner of Ontario 2009).

The large-scale inundation of Ontario and Quebec wetlands, particularly lake marsh habitat, with *Phragmites australis* may decrease species richness and significantly alter micro-habitat features. This may have a negative impact on amphibian development and survival (Perez *et al.* 2011). Extensive areas of Lake Huron and Lake Erie shoreline and marsh habitat have already been converted to a mono-culture of this tall, dominant, and rapidly expanding invasive reed (Gillingwater pers. comm. 2012).

In the long term, Eastern Ribbonsnake recovery is linked to the availability and health of wetlands and to the abundance of amphibian prey within these wetlands (Harding 1997). Despite the greater severity of threats in some parts of Ontario, little information is available with which to assess the population and to identify threats and trends.

## PROTECTION, STATUS, AND RANKS

### Legal Protection and Status

Atlantic Population

In 2002, COSEWIC designated the Atlantic population as Threatened because it is a small isolated population that is susceptible to demographic and environmental fluctuations and is threatened by shoreline development (COSEWIC 2002). The population was subsequently listed on Schedule 1 of the federal *Species at Risk Act*. The Atlantic population is also listed as Threatened under the Nova Scotia *Endangered Species Act* for the same reasons.

The National Recovery Strategy for the Atlantic population was posted in 2011 (Parks Canada 2012) and an Action Plan is currently in development.

Great Lakes Population

In 2002 COSEWIC designated the Great Lakes population as Special Concern because of the lack of quantitative data on population size and trends, the extreme loss of wetland habitats and modification of shoreline habitats, and the species' high susceptibility to road mortality (COSEWIC 2002). The species was subsequently placed on Schedule 1 of the federal *Species at Risk Act* as Special Concern. A management plan under SARA requirements does not appear to exist.

Eastern Ribbonsnakes in Ontario are also identified as Special Concern under the Ontario *Endangered Species Act, 2007*. They are not yet listed under Quebec provincial legislation.

**Non-Legal Status and Ranks**

The Eastern Ribbonsnake is listed as Least Concern in the IUCN's Red List of Threatened Species, with a stable population trend globally (IUCN 2011).

The Eastern Ribbonsnake is listed as Globally Secure (G5) by NatureServe (2012, last reviewed 2006) with a National Status of N3 in Canada. It is listed as Imperiled (S2) in Nova Scotia, Imperiled (S2) in Quebec (http:/www3.mrnf.gouv.qc.ca/faune/especes/menacees/liste.asp#suseptibles) and Vulnerable (S3) in Ontario.

Eastern Ribbonsnakes in Nova Scotia are a Yellow-ranked species under the province's General Status Assessment, meaning they are sensitive to human activities or natural events (www.gov.ns.ca/natr/wildlife/genstatus/ranks.asp).

**Habitat Protection and Ownership**

In both populations, Eastern Ribbonsnakes occur on a mix of private, federal and provincial Crown lands. They are found in a number of protected areas in both populations, though this represents a small percentage of their overall ranges.

Atlantic Population

A significant number of Eastern Ribbonsnakes is found at three sites in Kejimkujik National Park and National Historic Site. Additional Eastern Ribbonsnakes sites occur in the provincially protected Tobeatic Wilderness Area and in Lake Rossignol Wilderness Area. As well, a number of small properties containing Eastern Ribbonsnakes have been protected by Nova Scotia Nature Trust. A number of additional sites containing Eastern Ribbonsnakes have been identified as potential areas for protection through Nova Scotia's commitment to formally protect 12% of the province's land base by 2015. However, it is early in the process and it is not known how many, if any, of the sites will ultimately be protected (Nova Scotia Environment 2011).

Sightings have also been reported at both Kejimkujik Seaside (Parks Canada) and Thomas Raddall Provincial Park but neither record has been confirmed (NS Ribbonsnake Database 2011).

Great Lakes Population

Eastern Ribbonsnakes occur in Bruce Peninsula National Park, Georgian Bay Islands National Park, St. Lawrence Islands National Park and Trent-Severn Waterway National Historic Site. There are historical records from Fathom Five National Marine Park and they potentially occur in Rideau Canal National Historic Site (Howes, pers. comm. 2012; Haselmayer pers. comm. 2011). They occur in the Big Creek and Long Point National Wildlife Areas.

Eastern Ribbonsnake records also exist in a number of provincial protected areas (COSEWIC 2002). Many of these are based on a small number of sightings and the current status in most of these areas is unknown.

Eastern Ribbonsnakes are also found in several of Ontario Nature's Nature Reserves (Crowley 2009; Urquhart pers. comm.2011). Relatively high densities of sightings were recorded during recent surveys in Kinghurst Forest Nature Reserve, Lyal Island Nature Reserve (Crowley 2009) and Lost Bay Nature Reserve (Urquhart pers. comm. 2011).

In Quebec, several properties where the species has been observed are protected by the Nature Conservancy of Canada. There are also public lands, owned by Hydro-Québec, in the area occupied by the species in Bristol (Gauthier pers. comm. 2012)

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